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Marine science and blue growth: Assessing the marine academic production of 123 cities and territories worldwide

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ABSTRACT

The role of academic research in the economic growth process has been widely considered over the last two decades in the theoretical and empirical literature, particularly around the concept of knowledge-based economy. Meanwhile, the very recent notion of "blue growth" and the significant development potential related to marine environments have gained more and more concern for policy makers on different scales. It is therefore interesting to assess the academic research related to marine issues, owing to its potential contribution to this dynamics growth through knowledge transfers and academic spillovers. This paper provides a global evaluation of the marine academic production, using a spatialized, open and transdisciplinary approach. In particular, this approach is to mobilize indicators to assess scientific production, transpose it to the territorial scale and make a global comparison of "research territories" in the case of marine science, with a specific focus on European cities. The results show that the five main centres are Tokyo (Japan), Paris (France), San Diego (USA), Moscow (Russia) and Woods Hole (USA). A dense European territorial coverage in marine science centres also appears, and new world major centres such as Chinese and Brazilian ones emerge.

1. Introduction

The crucial importance of information, knowledge and technology in the economic growth process has been more strongly highlighted by many researchers since the 1990's. Work relating to the knowledge-based economy [1–6] showed the need to study and understand who generates knowledge, how it can spread and how the knowledge networks work. In this context where knowledge becomes "the most fundamental resource in the modern economy" [4], academic research, i.e. scientific research, appears as a strategic activity and resource. Indeed, academic research is one of the main knowledge-generating actors. It is therefore natural to wonder about the role that this actor can play in the growth dynamic, a role increasingly expected by policy makers, at a macroeconomic level but also at regional and local levels.

A first type of research activity effect on the economy is its multiplier effect: it can be called "effects on demand" or "expenditure impacts" [7]. It impacts regional income and employment. This is the direct contribution of the research infrastructure (e.g. a university) to the regional or national economy: the number of direct jobs (researchers and staffs), the local consumer spending of these researchers and staffs, or also research infrastructures spending in supplies, equipment and services. Many case studies have been conducted, especially in North America and the United Kingdom, using surveys or input-output tables [8–11]. But these "effects on demand", although interesting, are not the most important impacts. Indeed, in terms of wealth creation and economic development potential, it is more interesting to focus on a second type of research activity effect: the knowledge transfer effects, in the broadest sense. This second type can be called "effects on supply" or "knowledge impacts" [12] or "knowledge spillovers" [13]. These are all transfers existing between academics and economic supply actors, primarily industries, companies. Generally, these transfers are made through two "productions" specifically related to academic research: producing highly qualified graduates that can then be hired by companies [13,14]; and knowledge production, which can then be disseminated to companies through various channels: patents, licenses, spin-off companies, cooperation, co-funded theses, collaborative projects, publications [15–17]. The knowledge-based economy theorists focus more on this second type of research impacts – the effects on supply. The model of the Triple Helix relationships between university, industry and government [18–20] provides an interesting analytical framework.

Among the observations made in these studies, two elements call for our attention: the "size factor" and the "concentration factor". There seems to be a direct relation between the size of the research infrastructure, the amount of produced knowledge and the concentration of researchers in the same place on the one hand; and the effectiveness

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and strength of knowledge transfer observed, on the other. In other words, the more numerous researchers and knowledge – and the more spatially concentrated they are – the higher the probability of observing a large number of knowledge transfers.

In addition to these developments around the link between research and economy, the economic and demographic context in the world is undergoing profound changes. The world population growth, the concentration of inhabitants on coastal fringes, the ever-growing needs for resources, and concerns related to the environment are as many factors leading to re-assessing development models and usual economic schemes. Economic issues related to sea and ocean then become increasingly important: the terms “blue economy” and “blue growth” appear and are taken up by many institutions [21].

This paper's study starts from this two-fold observation – the link between research and economy, and the emergence of the concept of blue growth – and proposes a global analysis of the current situation and temporal evolution of academic production related to marine issues. Our approach is spatialized, open and transdisciplinary. This approach is to mobilize indicators to assess scientific production, transpose it to the territorial scale (city) and make a global comparison between “research territories” in the case of marine science. European cities are more numerous in the analysis: the European level is indeed particularly interesting because of the highly-structured EU marine policy. The paper is constituted as follows: first, an overview of the place given to the marine-related issues in recent European history is presented. Then, the paper focuses on the factors that determine the effectiveness and strength of academic knowledge transfer, and in particular the “size” and “concentration” factors. Thirdly, the method used to evaluate the academic potential of European territories in marine science is explained as based on spatialized scientometrics. Finally, the results of our comparative study are presented and analysed.

2. Policy-makers and marine-related issues: some benchmarks

First: how policy-makers – particularly at state and European Community levels – have progressively integrated marine and maritime issues, should be analysed briefly.

At the European Community level, Horizon 2020, the last and most important EU Research and Innovation program includes a part devoted to blue growth. The European Commission has defined a “Blue Growth Strategy”: “a long term strategy to support sustainable growth in the marine and maritime sectors as a whole” [21]. The authorship of the term “blue growth”, or “blue economy” seems to be attributable to Gunter Pauli [22]. Originally, it is more of an alternative economic model, based on the principles of sustainable development and circular economy: this model is to meet the basic needs using what is available locally. This term today refers to all economic activities related to the sea and the wealth they create, including those on the sustainable exploitation of new resources. But European policies have not always incorporated the concerns related to the sea, on the contrary. First came the Common Fisheries Policy in 1983. Then, in 1992, within the Natura 2000 network, a set of protected marine areas was created, aiming at preserving nature and socioeconomic concerns. But not until the beginning of the 21st century did the concept of EU Integrated Maritime Policy (IMP) appear in the European institutions. It was finally adopted by the European Union in 2007. This maritime policy is focused on “blue growth”. The goal is to provide for a sustainable and controlled exploitation of the ocean through a comprehensive approach of maritime environment.

During the last decade, the concern of the European institutions for marine issues increased. The sea has even become a “crucial” element: “The ocean and seas are crucial for Europe. In fact our continent is the second-smallest continent in terms of its land area, but we sit between two oceans and five seas and have a coastline of 70,000 km” [21]. Several studies have attempted to estimate the growth potential linked to the sea. In 2014, Gavigan suggests estimates of 5.4 million jobs in the global blue economy, with a possible increase to 7 million in 2020. As for Mees, the Chair of the European Marine Board, he suggests at the same time a figure for the estimated gross value added of the European maritime economy: €500 billion per year. For United Kingdom only, the UK Marine Industries Alliance [23] estimates that marine-related sectors employ nearly 90,000 people, in 5000 companies, but highlights that “greater cooperation across the marine industries and maritime services sector could see their value to the UK economy rise from the current £17 billion a year to £25 billion a year by 2020”. The most promising development areas are ocean energy, aquaculture, biotech and deep sea resources.

In this context, marine research gradually appears as an essential element. Since 2006, the European Commission has identified marine research as a key element of maritime policy in the future [21]. The “European Strategy for Marine and Maritime research” was adopted in 2008, and has become an essential pillar of the EU Integrated Maritime Policy. In 2010, the Commission underlined the “vital” and the “crucial” role that marine science and technology must now play in this blue growth dynamic. In its 2014 conference, Eurocean, the European Centre for Information on Marine Science and Technology, noted that the “collaborative and cross-disciplinary European research is the key to providing the knowledge and tools that we need” to ensure blue growth sustainably and efficiently. On this occasion, four main objectives were defined, three of which relate to marine research: “valuing the ocean”, “reinforcing Europe's position as a global leader in marine science and technology”, “building a much greater knowledge basis through ocean observation and fundamental and applied research”, “breaking scientific barriers combining expertise and drawing from a full range of scientific disciplines”.

Beyond discourses and objectives, significant funds have been used for years for European maritime policy. Already in the FP7 program, €195 million and 31 projects were allocated to marine and maritime research. Today, within the Horizon 2020 program (€80 billion of funding available over 7 years, 2014–2020), the first “Blue Growth Call” has resulted in a €145 million injection of funds (for 2014–2015), and the second call for projects is underway.

However, the community action sometimes masks large disparities. Faced with the need to consolidate and integrate the numerous and dispersed elements of marine legislation and planning [24], the United Kingdom has gone the furthest, by developing a comprehensive marine planning document: the UK's Marine Policy Statement [25], defined as “the framework for preparing Marine Plans and taking decisions affecting the marine environment”, and whose aim is to ensure optimal exploitation of the ocean both economically and environmentally. Besides the UK's Marine Science Strategy and associated Marine Science Coordination Committee has furthered much more consistent and shared thinking than would have otherwise been the case, and has directly influenced how other countries are looking to structure future work on marine science and blue growth [26,27]. The other European countries seem to be more like “followers”. Thus, among European keys-players – countries where marine research production is among the highest – France or Germany still do not have a clear overview of the budgetary effort devoted to sea-related sectors. France recently set up a National Sea and Coastal Council, to strengthen the coordination of public actions in the coastal territories and to provide the implementation of the National Sea and Coastal Strategy (SNML), but its policies remain sectoral. Another such case: Portugal, the European country with the fastest growing marine research production, initiated a Marine Spatial Plan in 2008, having first developed a National Sea Strategy in 2006: once again, if the approach appears to be necessary, its implementation still faces problems, both operational and conceptual [28].

Meanwhile, several non-EU other countries have become aware of the essential contribution that sea-related activities could bring to national economies. Thus, several national maritime policies have been